REAL TIME OBJECT TRACKING

DESIGN PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of

the degree of ***Bachelor of Technology***

in ***Electronics and Communication Engineering***

under the ***Kerala Technological University***

Submitted by

ABUBAKAR RASHAD P.V. (TVE17EC004)

DIVAKAR MAHESH S. (TVE17EC016)

SIDHARTH N. (TVE17EC046)

SREEJITH S. (TVE17EC049)

Fifth Semester

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

COLLEGE OF ENGINEERING

TRIVANDRUM

2019

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

COLLEGE OF ENGINEERING, TRIVANDRUM

2019

CERTIFICATE

*This is to certify that this report entitled "**Real Time Object Tracking**" herewith is a bonafide record of the design project done by **Abubakar Rashad PV, Divakar Mahesh S, Sidharth N** and **Sreejith S** under our guidance towards partial fulfilments of the requirements for the award of **Bachelor of Technology Degree** in **Electronics and Communication Engineering** of the Kerala Technological University during the year **2019**.*

Prof. Sanil K. Daniel
Assistant Professor
Dept. of ECE
College of Engineering
Trivandrum
(Guide)

Dr. Santhosh Kumar S.
Professor and Head of Dept.
Dept. of ECE
College of Engineering
Trivandrum

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any idea / data / fact / source in our submission. We understand that any violation of the above will cause for disciplinary action by the Institute and can also evoke penal action from the sources which have not been properly cited or from whom proper permission has not been taken when needed.

Project Team

ACKNOWLEDGEMENT

Any mission never completes without the cordial co-operation from surroundings. We take this opportunity to acknowledge all the people who have helped kind heartedly in every stages of this project.

We would like to express our sincere gratitude to this institution, College of Engineering, Trivandrum, for the worthy support extended to us. We also thank our honorable principal **Dr. Jiji C.V,** for providing us with best facilities and atmosphere for our project development and its realization.

We are profoundly indebted to **Dr. Santhosh Kumar S**., Head of the Department, Department of Electronics and Communication for providing us the ambience for carrying out the work of our project.

It is a matter of great pleasure and satisfaction for us to express our sincere gratitude and appreciation to our guides **Prof. Sanil K. Daniel** and **Prof. Jithina T.S.** for their valuable guidance, constructive criticism and encouragement throughout this project.

This acknowledgement will stand incomplete if our parents, friends, seniors & classmates are not thanked for enduring their prayers and support to us, which was inevitable for the realization of this work. Last but not the least we are thankful to each other in this project group being co-operative, patient and hardworking for the successful completion of the project.

PROJECT TEAM

Abstract

India is widely believed to have arrived on the global state. India has successfully positioned herself as one of the core members of influential nations. But the security scenario of India has attracted more vulnerability and complexities like never before as India has the disadvantage of being situated in close proximity to what is being described as the epicentre of global terrorism. We aimed to find a suitable and effective solution for the above-mentioned problems. Here by it clarifies the significance of an automatic firing system which will replace soldiers with its effective protective measures. Our defence system comprises of features like video recording, automatic human recognition, automatic motion sensing, automatic firing etc. this system, video cameras and processing in hand with embedded system can not only detect intrusion attempts, but also provide a video coverage of the suspicious area, for remote vigilance. Also, our system can withstand extreme climatic condition, thus requiring less maintenance. In this concept we have designed a promising prototype, to implement Real-Time object tracking and develop improved and more efficient methods for CCTV surveillance which on further development with sufficient time and resources, can be raised to international level.

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REPORT OUTLINE

The chapter organization of the report is as follows:

Chapter 1: This chapter gives a brief introduction about the project, the problem statement and the expected outcomes of the final product.

Chapter 2: This chapter provides a brief overview about the background study carried out before the start of work. Literature referred are also mentioned.

Chapter 3: The methodology of the proposed system is explained with a flowchart and a block diagram. The steps followed by the system to get the expected outcome is clearly explained.

Chapter 4: This chapter gives a brief overview of the steps involved in processing of a video signal.

Chapter 5: This chapter deals with the hardware and software implementation of the project. The cost estimation of the components has also been done.

Chapter 6: This chapter deals with the results obtained, conclusion and future scope of the project.

Chapter 1

1.1 Introduction

Identifying human presence in a visual surveillance system is crucial for variety of applications. Various tracking systems are also refined with a vision to detect human beings. However lesser resolution pictures make them a challenging one. So, a stereo vision based human detection and tracking system is proposed for recognition of intruders in the human access-controlled areas and can help in observing and inspecting illegal activities. In this depth range of the system is used in parameter estimation. The human presence is identified by skin detection where segmentation is done in HSV colour space. Human tracking is a separate hardware system coupled through a serial port. For targeting servo motors are used, along a buzzer and a laser light for pointing the target. Here the presence of animals is also eliminated by a change in algorithm. The proposed implementation need only less protection and climate conditions are least influenced.

Fig 1.1.1: Skin colour detection

1.2 Problem Statements

Presently our borders are protected by iron spike fences and a watchtower containing soldiers, continuously flashing the light over the border area. Those persons are fully responsible to prevent any intrusion. This system will not fully remove the responsibility of the soldiers, but manages to take the maximum responsibility and thus reduces human mistakes on the border. The basic purpose is to enhance the border security electronically with automation and with that to reduce the work load and responsibility of the soldiers who has to work continuously on the border.

Fig. 1.2.1: Patrolling the borders

1.3 Objectives

The main objective of the project is to design a "Real Time Object Tracking System" that detects and tracks red coloured objects.

Through this project, we seek to

- Implement Real-Time object tracking and develop improved and more efficient methods for CCTV surveillance using Computer Vision (OpenCV).
- Employ image processing in which a camera will be continuously observing the area under surveillance.
- Develop a real time red coloured object tracking device which with sufficient time and resources, can be modified to a real time human detection and tracking system.

Chapter 2

2.1 Background Study

The background study was centred on understanding the various technologies used in defence around the world.

India is the largest arms importer in the world. It is imperative that the long-term requirement of capability be identified and understood for appropriate technology to be developed indigenously by the Indian Armed Forces. The DRDO has already been working on enhancing the technology used in the equipment in the forces.

To get the visual information of object so many tracking systems are being developed. Object detection is the main function and tracking gather the latest position of object. Targeting systems are developed from tracking systems by incorporating a movable physical part which points / targets to the detected object. Intelligent human detection and targeting system identifies human and points the targeting device to human.

The stereo vision detection establishes the depth between camera and the human. This system identifies the human and track its location with an image processing application. 3D model of the object is used to track its distance. Skin colour modelling in HSV colour space is used to recognize the presence of the human. Two servo motors are used to achieve the two-dimensional motion of the targeting device in the microcontroller unit.

India is importing a lot of arms and technology for its forces. Since January 2018 alone, it has made 11 technology deals. This is good for the enhancement of the armed forces but will not benefit the country in the long run, unless we make our own technology.

2.2 LITERATURE REVIEW

The analysis of the management and control of external borders reflects the areas and practices based on the EU legislative and policy framework. Although inter-agency cooperation as part of the integrated border management (IBM) concept is recognised as one of the components of integrated border management, there is limited analysis of the potential or effectiveness of existing models of such cooperation.

Although there is no clear definition of integrated border management shared within academic research,75 various articles list inter-agency cooperation as one of the 'features' (Carrera, 2007: 3) 'basic elements' or main 'basic principles' (Hobbing, 2005: 4) of integrated border management. While the literature discusses the roles of the different agencies in the efficient handling of borders, there is generally a lack of academic perspective on the interrelatedness of the different agencies in providing border security.

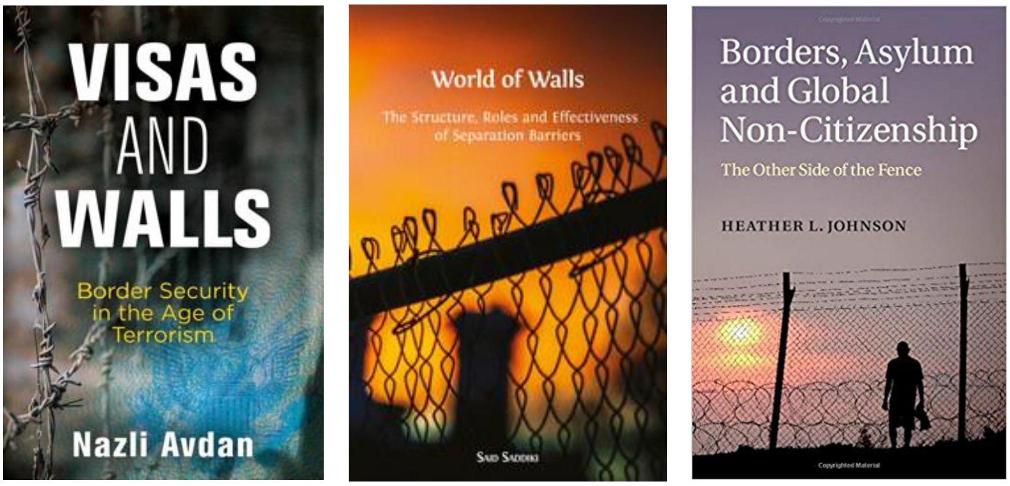


Fig. 2.2.1: Literature on border security

The External Borders Practitioners Common Unit (EBPCU), which was later replaced by Frontex, was a forum composed of managers from the operational level of visa and enforcement authorities, such as police, Customs, and justice. It is often cited as another example of a multidisciplinary approach towards border control (Hobbing, 2005: 14). EBPCU's functions are briefly outlined, but there is no analysis of its activities and their effectiveness.

CHAPTER 3

3.1 PRODUCT DESIGN

The flowchart for real time object racking is shown below:

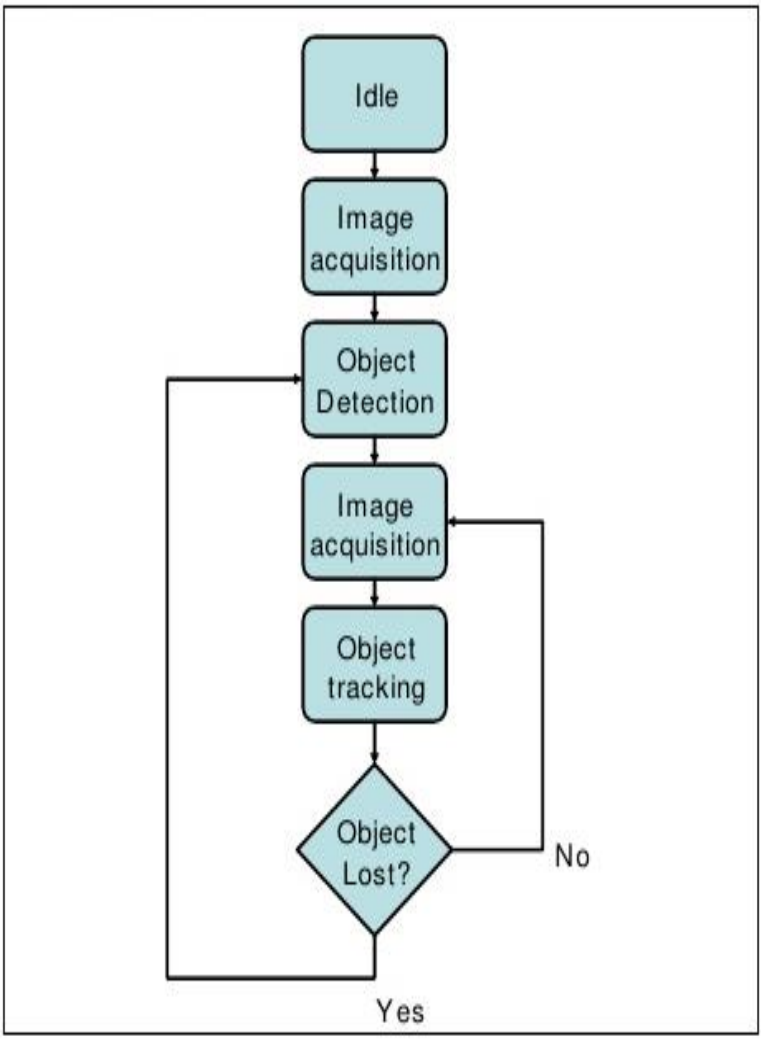


Fig 3.1.1: Flowchart for object tracking

3.2 Block Diagram

The block diagram of the proposed system is shown:

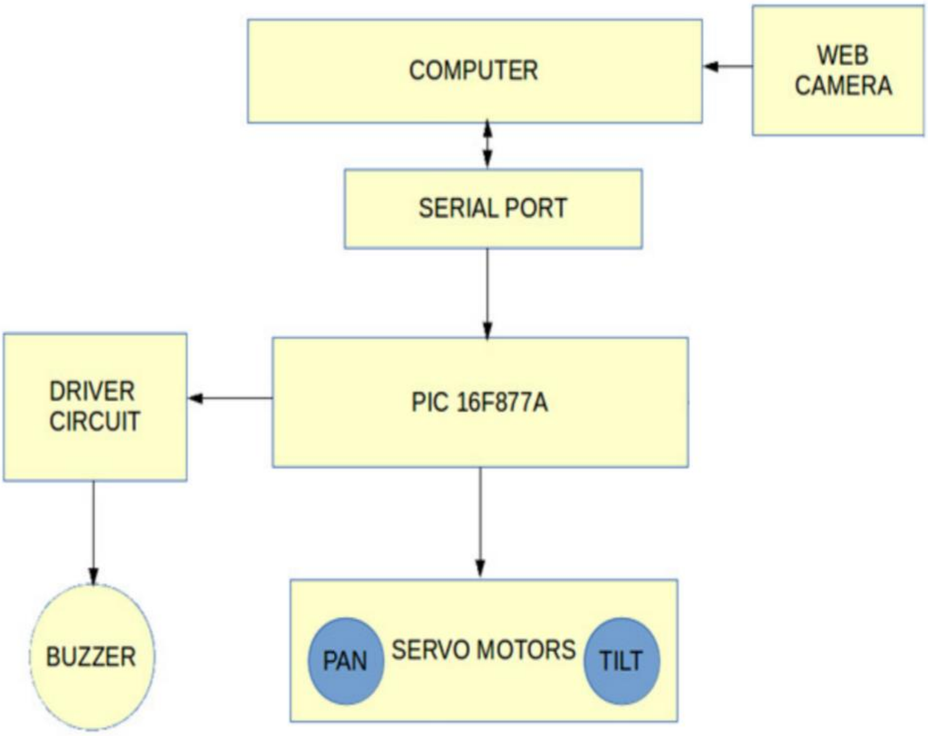


Fig. 3.2.1: Basic block diagram

3.3 Working

The block diagram represents the components of the proposed system, which includes the web camera, computer, serial port, microcontroller, servomotors, buzzer and driver circuit for activating it. Web camera is for the purpose of recording and monitoring. When a red coloured object is brought to frame, web camera identifies and gives the video input to the computer. Computer processes the video and determines the X-Y position coordinates of the object and the angles to which the servomotors has to be moved to focus the object. Computer gives this data to the microcontroller, which is linked with the computer through a serial port enabling the communication of signal processing unit with the microcontroller. According to the signal obtained from the computer, microcontroller controls servomotors (pan and tilt) and buzzer. Microcontroller activates the servomotor to which the laser is attached and it will be delayed by the pulse width obtained after processing the data from the microcontroller. Here pulse width is taken into account because servomotor is a pulse activated motor. After determining the pulse width microcontroller activates the buzzer through a driver circuit, informing that there is some red coloured object identified. Now the laser in the servomotor points at the red coloured object.

3.4 Circuit Diagram

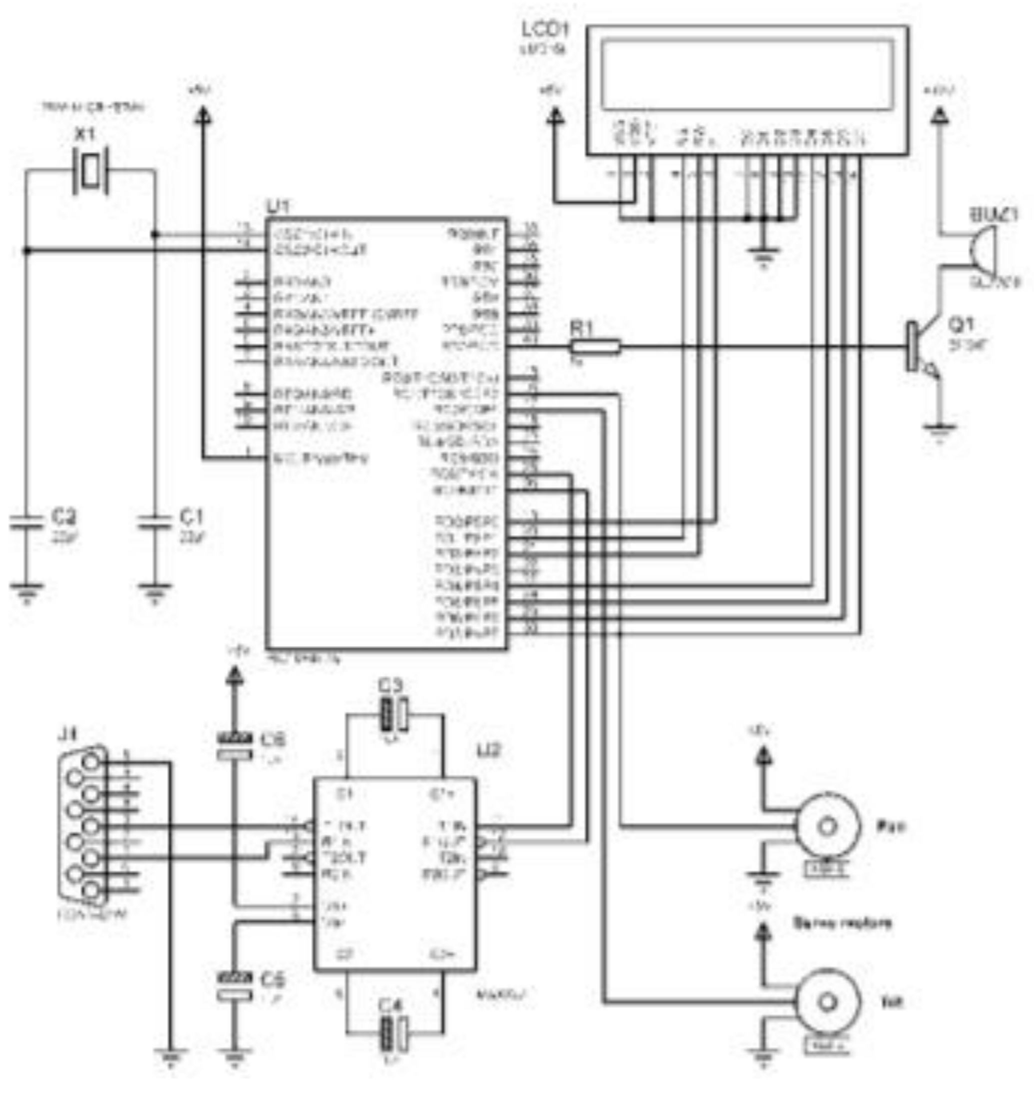


Fig 3.4.1: Basic circuit diagram

Chapter 4

4.1 Processing of Video Signal

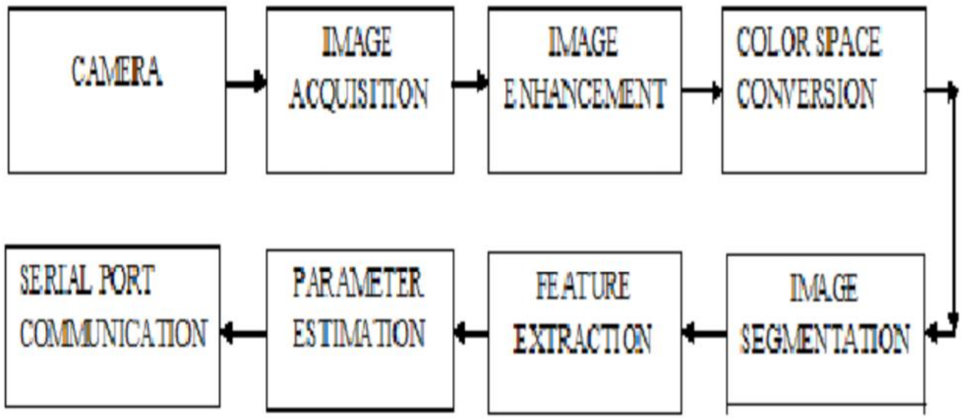


Fig 4.1.1: Steps in video signal processing

After receiving the video from the camera, computer performs following operations for processing the video signal for the purpose of human identification.

A. IMAGE ACQUISITION

The process of obtaining an image from a hardware-based source, after which it can be passed through whatever processes need to occur afterward is called image acquisition in image processing. It is always the first step in the image processing. The image that obtained will be completely unprocessed and is the result of whatever hardware was used to obtain it. So, it will be easier to locate and eliminate the abnormal factors present in the image reproduced when a source of input is operated within controlled and measured guidelines. Two important factors involved in image acquisition are the initial setup and long-term maintenance of the hardware which is used to capture the images. Here the actual hardware device used is camera. If the camera is not properly configured and aligned, then visual artefacts may be produced that can make the image processing complicated. Also, it may provide such low-quality images so that they cannot be extracted even with extensive processing. In real time image acquisition images are obtained from a source that captures images automatically and creates a stream of files that can be automatically processed and queued. One common technology that is used with real-time image processing is known as background image acquisition, which describes both software and hardware that can quickly preserve the images flooding into a system.

B. IMAGE ENHANCEMENT

Image enhancement improves the interpretability of information in images and provides better input for other automatic image processing techniques. In image enhancement the principal objective is to modify attributes of an image to make it more suitable for a given task and a specific observer. During this process one or more attributes of the image are modified. Choice of attributes and the way they are modified are selected depending on the task. The image enhancement methods are broadly classified into the following two categories:

1. Spatial Domain Methods

2. Frequency Domain Methods

Spatial domain techniques directly deal with the pixels in image. Here pixel values are changed to achieve required enhancement. In frequency domain methods, the image is first transferred in to frequency domain. Here at first the Fourier Transform of the image is computed. Then in the Fourier transform of the image all the image enhancement operations are carried out. Then the Inverse Fourier transform is determined to get the resultant image. Enhancement operations are done to modify the brightness of images and contrast or the distribution of the grey levels. As an outcome the pixel value of the output image will be modified according to the transformation function applied on the input values. Here spatial domain methods of image enhancement are used.

C. COLOR SPACE CONVERSION

Using RGB colour space or HSV colour space colour vision can be processed. RGB colour space describes colours in terms of the amount of red, green, and blue present. HSV colour space describes colours in terms of the Hue, Saturation, and

Value. The HSV colour model is often preferred over the RGB model in situations where colour description plays an integral role. The HSV model describes colours similarly to how the human eye tends to perceive colour. RGB defines colour in terms of a combination of primary colours, whereas, HSV describes colour using more familiar comparisons such as colour, vibrancy and brightness.

- Hue is representation of the colour type. It can be described in terms of an angle on the above circle. The hue value is normalized to a range from 0 to 255, with 0 being red.
- Saturation is representation of the vibrancy of the colour. Its value ranges from 0 to 255. Lower the saturation value, more grey is present in the colour. • Value is representation of the brightness of the colour. Its value ranges from 0 to 255, with 0 being completely dark and 255 being fully bright.
- White is having an HSV value of 0-255, 0-255, 255. Black is having an HSV value of 0- 255, 0-255, 0.

D. IMAGE SEGMENTATION

Image segmentation refers to the separation of an image into a set of regions that covers it. Groups of pixels having both border and a particular shape are known as regions. When the interesting regions do not cover the whole image, we can think about segmentation. Segmentation has two objectives. The first objective is to classify the image into parts for further processing and analysis. The second objective of segmentation is to perform a change of representation. Image pixels must be organized into higher-level units that are more efficient for further analysis.

E. FEATURE EXTRACTION

It starts from an initial set of measured data and builds features intended to be informative, non-redundant, facilitating the subsequent learning and generalization steps, in some cases leading to better human interpretations. It is also related to dimensionality reduction. It deals with the reduction of amount of resources required to describe a large set of data. Analysis with a large number of variables generally requires a large amount of memory and computation power which over fits the training sample and generalizes poorly to new samples. To get around of these problems feature extraction is a general term giving data with sufficient accuracy

F. PARAMETER ESTIMATION

In parameter estimation the pan and tilt angle position of the intruder is calculated.

Chapter 5

5.1 HARDWARE IMPLEMENTATION

Output from the computer is transferred to the microcontroller through a serial port. Here the heart of the controlling unit is the microcontroller. As explained in the above section, the location of the suspected object is determined by the image processing algorithm. When the object is detected, the micro-controller performs two functions. First is to activate the peripheral device buzzer, to indicate the presence of the object. Secondly, to take the decision in order to control the movement of the gun that is attached on the servomotors.

After receiving the pan and tilt angle, microcontroller activates the buzzer through the driver circuit. Since servomotor is a pulse activated motor, microcontroller determines the pulse width corresponding to the pan and tilt angles. Then the servomotors are moved according to these pulse width values. After aiming, the microcontroller triggers the laser.

In this system there are two servomotors: Pan servomotor and tilt servomotor. Pan servomotor makes the movement of gun in the horizontal position and tilt servomotor in the vertical position. Compared to other motors servomotors are having several advantages like: high torque, high precision in position control, fast operation etc. In the proposed system, rotation is limited to 180°. Therefore, servomotors are more suitable.

5.2 Components Required

Fig. 5.2.1: Raspberry pi 3 b+

Fig. 5.2.2: Pi Cam

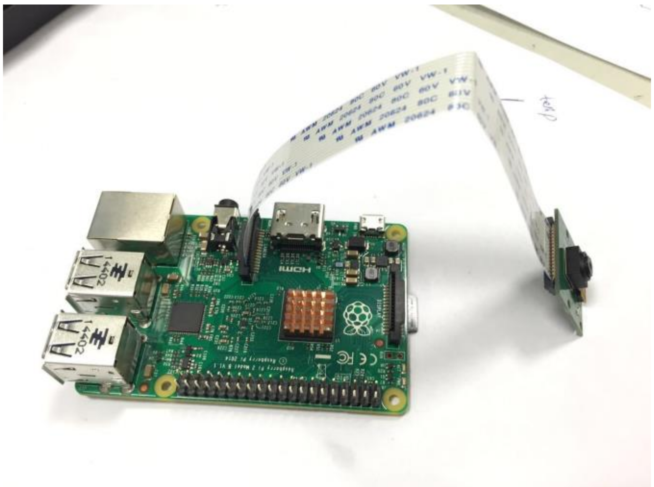


Fig 5.2.3: Pi Camera with OpenCV for Raspberry PI

Fig 5.2.4: Arduino UNO

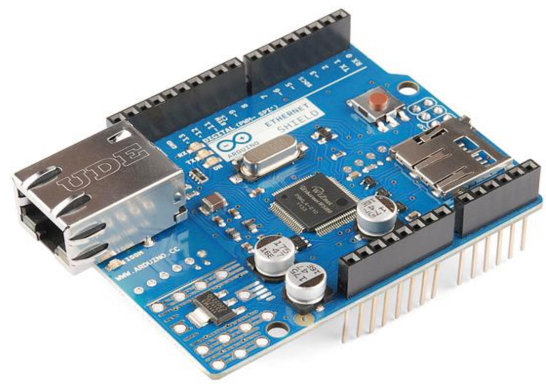


Fig 5.2.5: Arduino Shield

Fig 5.2.6: Servo Motor

Fig 5.2.7: VGA to HDMI Convertor

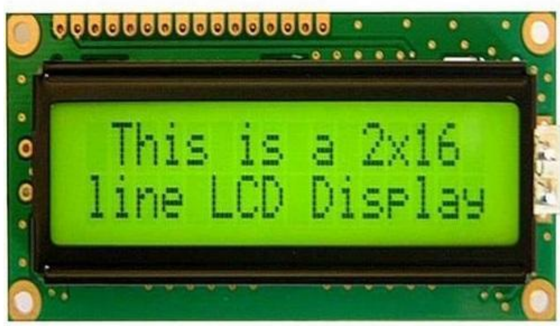


Fig 5.2.8: Laser Pointer

Fig 5.2.9: LM016l LCD

Fig 5.2.10: Buzzer

Fig 5.2.11: Transformer

5.3 COST ESTIMATION

SL NO.	COMPONENT	ESTIMATED COST
1	Raspberry pi 3 b+	₹3599
2	Pi cam vs	₹408
3	VGA to HDMI converter	₹215
4	Arduino Uno	₹405
5	Arduino shield	₹345
6	Servo motor (2)	₹1484
7	Laser pointer	₹295
8	LM016l LCD	₹158
9	Buzzer	₹89
10	Transformer	₹149

Table 5.3.1: Cost estimation

TOTAL COST OF COMPONENTS - ₹7417 (+extras)

5.4 Software Implementation

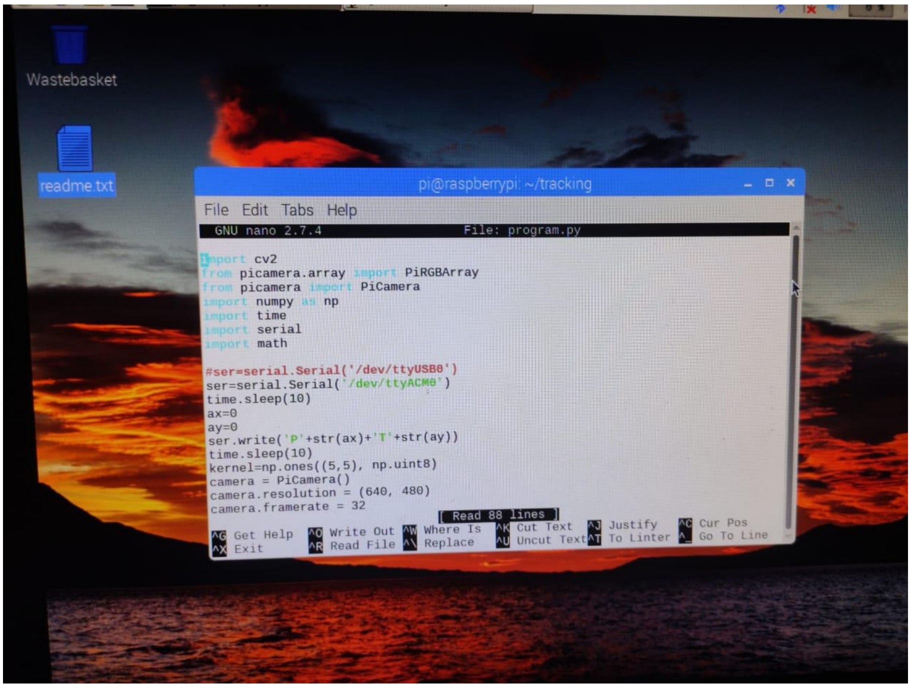


Fig 5.3.1: OpenCV code-1

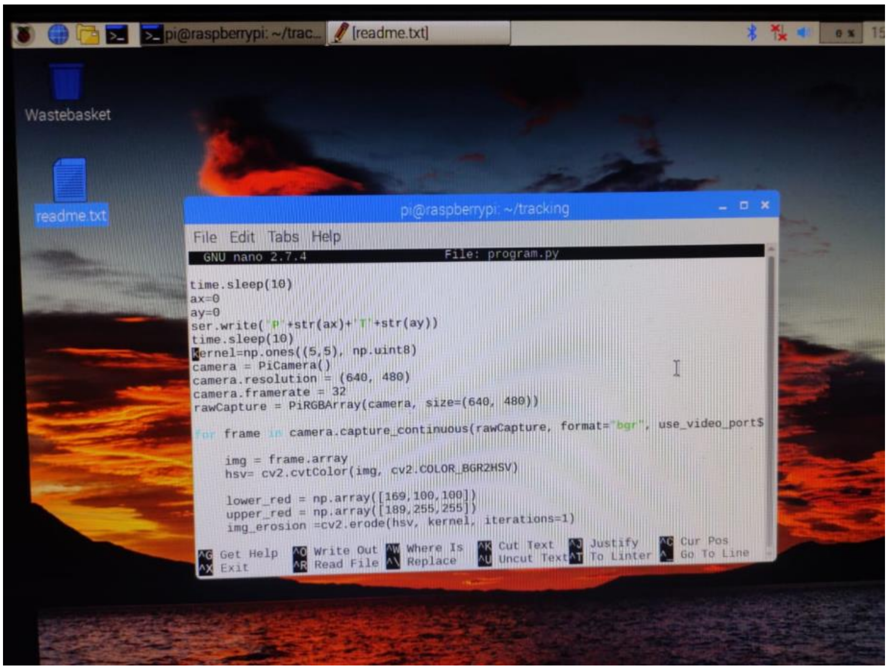


Fig 5.3.2: OpenCV code-2

Chapter 6

6.1 Final Product

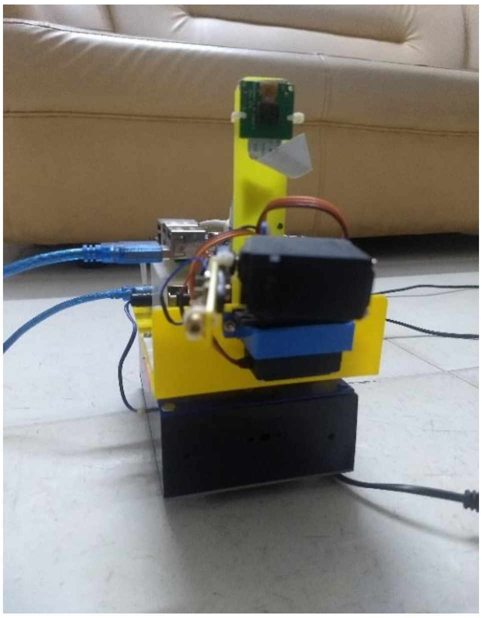


Fig 6.1.1: Front View

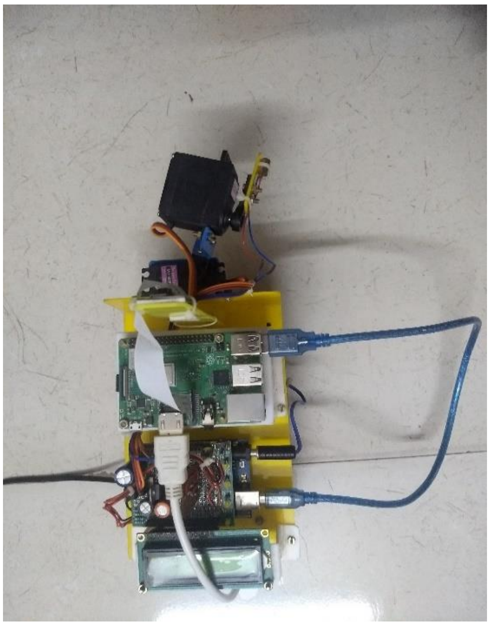


Fig 6.1.2: Top View

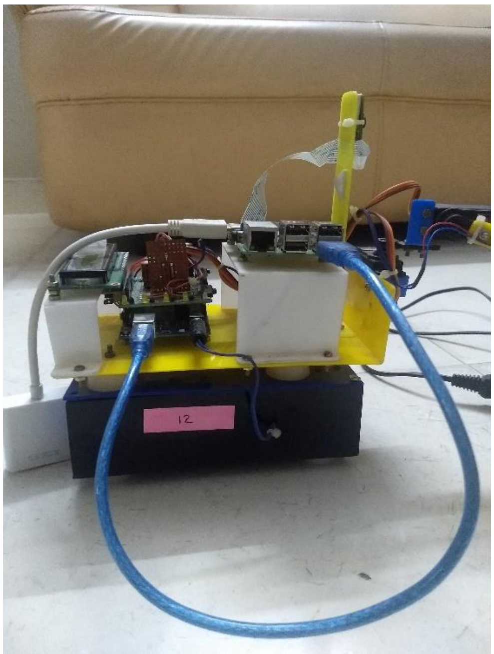


Fig 6.1.3: Side View

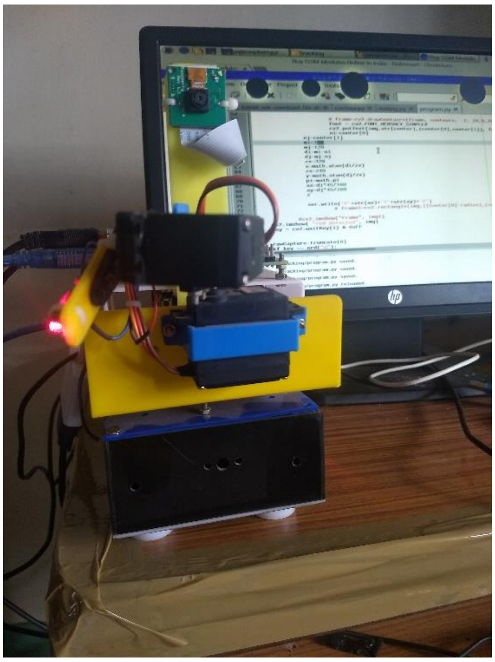


Fig 6.1.4: Device On

6.2 Results and Discussions

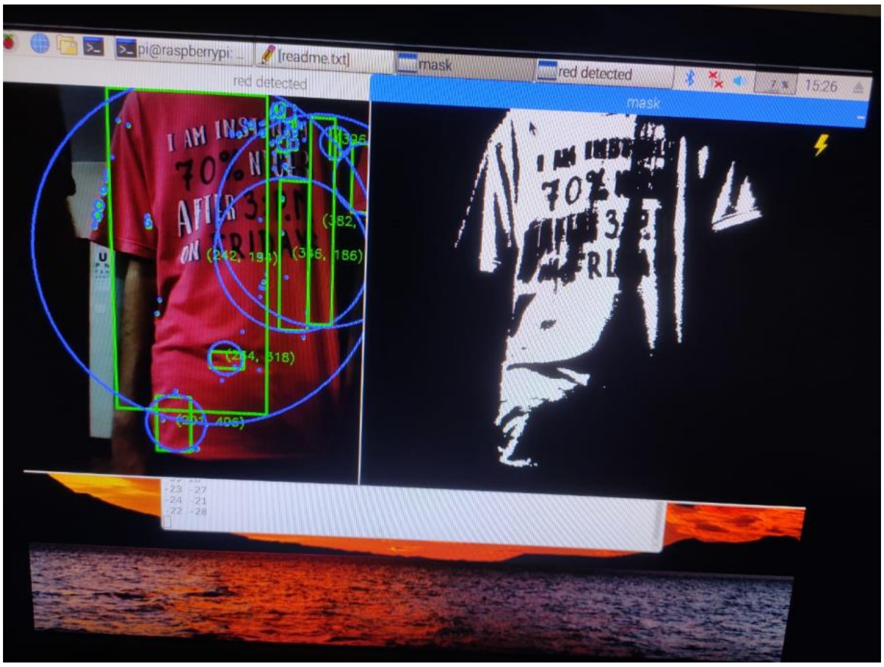


Fig 6.2.1: Red colour masking - 1

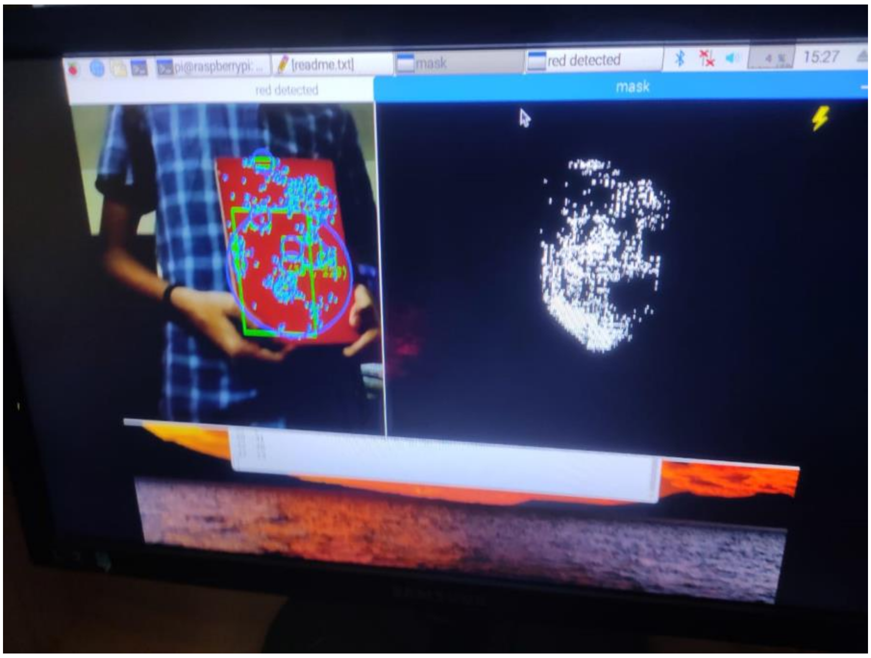


Fig 6.2.2: Red colour masking - 2

The above figure shows the output obtained from OpenCV code. In the figure green box indicates the bounding box showing the red coloured portion and the blue sign indicates the centroid of the portion.

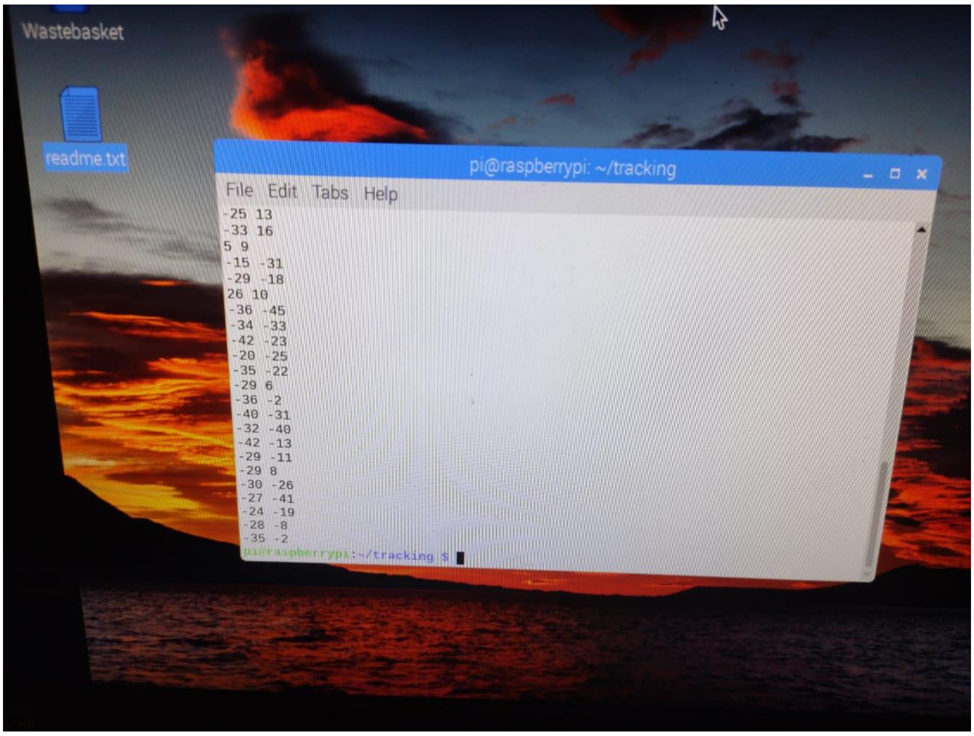


Fig 6.2.3: Co-ordinates of target object

The detection system and targeting system are separately arranged and interconnected via serial port. A laser light is used to indicate the location of targeted person. The output of the camera is displayed on a window in the computer monitor through mat lab and the pan, tilt angle is displayed on the LCD as a message. The pointing device(laser) was moved according to the movement of human with a negligible delay. A simple and effective communication can be established by sending angle information through serial port. The performance of microcontroller can drive the servo motors to synchronize with red colour detection system. The processed frames can also be saved as image file so that to generate a video file.

6.3 Conclusions

This project presents an idea of an intelligent border defence system with automatic aiming, targeting and triggering. This system will reduce the work effort of soldiers in the border. Since it is a fully automated system there will not be any manual error and hence it is more accurate. By using night vision cameras, it can work continuously. It is not so expensive and requires less maintenance. It can also withstand extreme climatic conditions. In this concept we have designed a promising prototype, which on further development with sufficient time and resources, can be raised to international level.

6.4 Future Scope

Possible additions to this project:

After completing the major milestones of this project, one or more of the following features may be added to it.

- Modify the red colour detection parameters to that of skin colour.
- Night vision cameras to track objects under dim light.
- Robotic system in human rescue operation and war field.
- Target location by estimating the distance of the human.

References

[1] https://ieeexplore.ieee.org/document/7159448

[2] https://ieeexplore.ieee.org/document/7854018

[3] http://ijiie.org/download/2015Aprilvol1n4.pdf

[4] http://www.ijiie.org/download/2015Aprilvol1n6.pdf

[5] http://ijiie.org/download/2015junevol1n4.pdf

[6] http://ijiie.org/download/2015Aprilvol1n3.pdf

[7] http://ieeexplore.ieee.org/document/7159376/

Appendix

Raspberry Pi 3 b+

RASPBERRY PI platform is most used after ADRUINO. Although overall applications of PI are less it is most preferred when developing advanced applications. Also, the RASPBERRY PI is an open source platform where one can get a lot of related information so you can customize the system depending on the need.

Here are few examples where RASPBERRY PI 3 is chosen over other microcontrollers and development boards:

1. Where the system processing is huge. Most ARDUINO boards all have clock speed of less than 100MHz, so they can perform functions limited to their capabilities. They cannot process high end programs for applications like Weather Station, Cloud server, gaming console etc. With 1.2GHz clock speed and 1 GB RAM RASPBERRY PI can perform all those advanced functions.

2. Where wireless connectivity is needed. RASPBERRY PI 3 has wireless LAN and Bluetooth facility by which you can setup WIFI HOTSPOT for internet connectivity. For Internet of Things this feature is best suited.

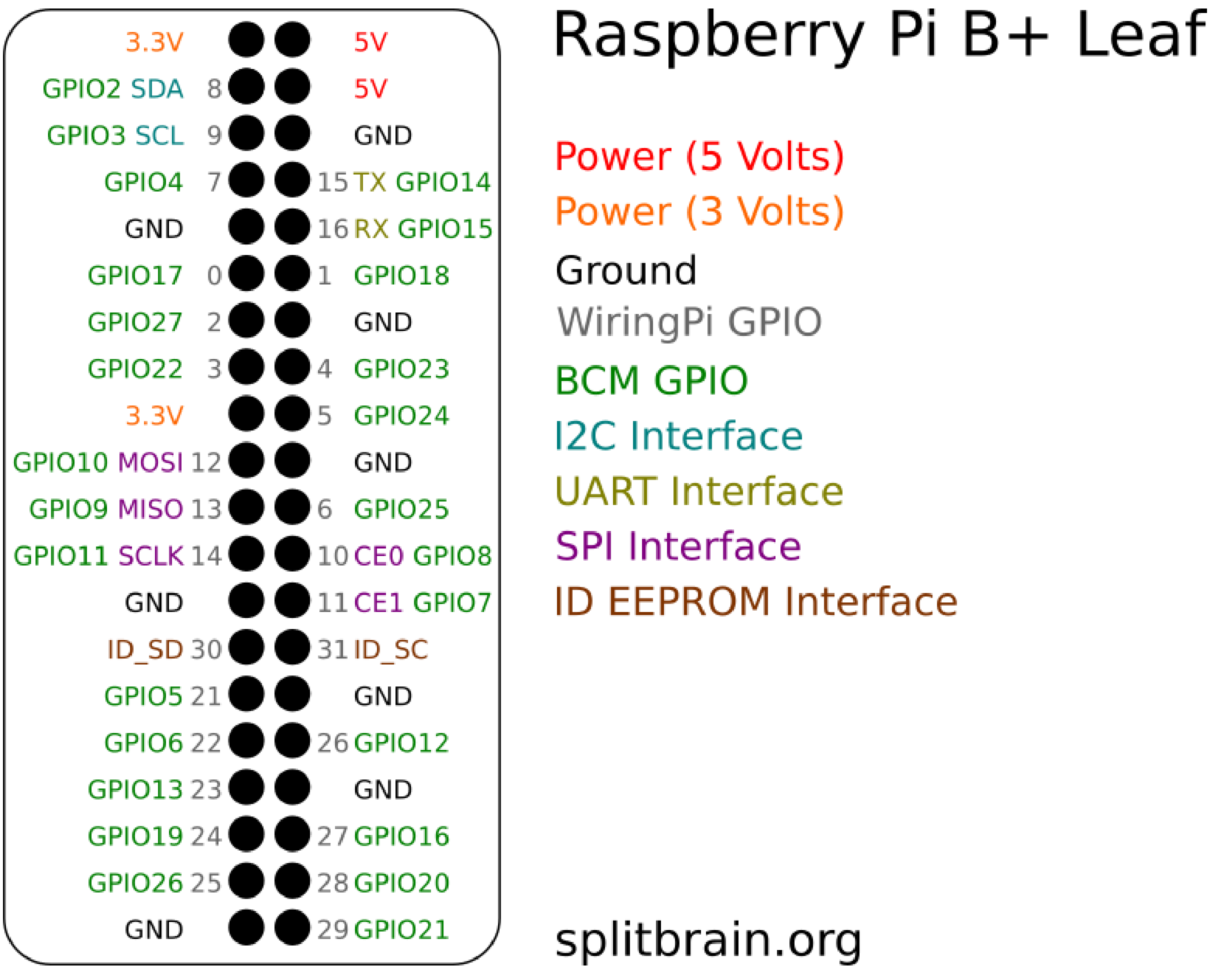
3. RASPBERRY PI had dedicated port for connecting touch LCD display which is a feature that completely omits the need of monitor.

4. RASPBERRY PI also has dedicated camera port so one can connect camera without any hassle to the PI board.

5. RASPBERRY PI also has PWM outputs for application use.

There are many other features like HD steaming which further promote the use of RASPBERRY PI.

Raspberry Pi - Pinout diagram



Raspberry Pi - Pin Configuration

PIN GROUP	PIN NAME	DESCRIPTION
POWER SOURCE	+5V, +3.3V, GND and Vin	+5V -power output +3.3V -power output GND – GROUND pin
COMMUNICATION INTERFACE	UART Interface(RXD, TXD) [(GPIO15,GPIO14)]	UART (Universal Asynchronous Receiver Transmitter) used for interfacing sensors and other devices.
	SPI Interface(MOSI, MISO, CLK,CE) x 2 [SPI0-(GPIO10 ,GPIO9, GPIO11 ,GPIO8)] [SPI1--(GPIO20 ,GPIO19, GPIO21 ,GPIO7)]	SPI (Serial Peripheral Interface) used for communicating with other boards or peripherals.
	TWI Interface(SDA, SCL) x 2 [(GPIO2, GPIO3)] [(ID_SD,ID_SC)]	TWI (Two Wire Interface) Interface can be used to connect peripherals.
INPUT OUTPUT PINS	26 I/O	Although these some pins have multiple functionsthey can be considered as I/O pins.
PWM	Hardware PWM available on GPIO12, GPIO13, GPIO18, GPIO19	These 4 channels can provide PWM (Pulse Width Modulation) outputs. *Software PWM available on all pins
EXTERNAL INTERRUPTS	All I/O	In the board all I/O pins can be used as Interrupts.

Table A.1: Raspberry Pi- Pin description

Raspberry Pi - Technical Specifications

Microprocessor	Broadcom BCM2837 64bit Quad Core Processor
Processor Operating Voltage	3.3V
Raw Voltage input	5V, 2A power source
Maximum current through each I/O pin	16mA
Maximum total current drawn from all I/O pins	54mA
Flash Memory (Operating System)	16Gbytes SSD memory card
Internal RAM	1Gbytes DDR2
Clock Frequency	1.2GHz
GPU	Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GLES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high- profile decode. Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure.
Ethernet	10/100 Ethernet
Wireless Connectivity	BCM43143 (802.11 b/g/n Wireless LAN and Bluetooth 4.1)
Operating Temperature	-40ºC to +85ºC

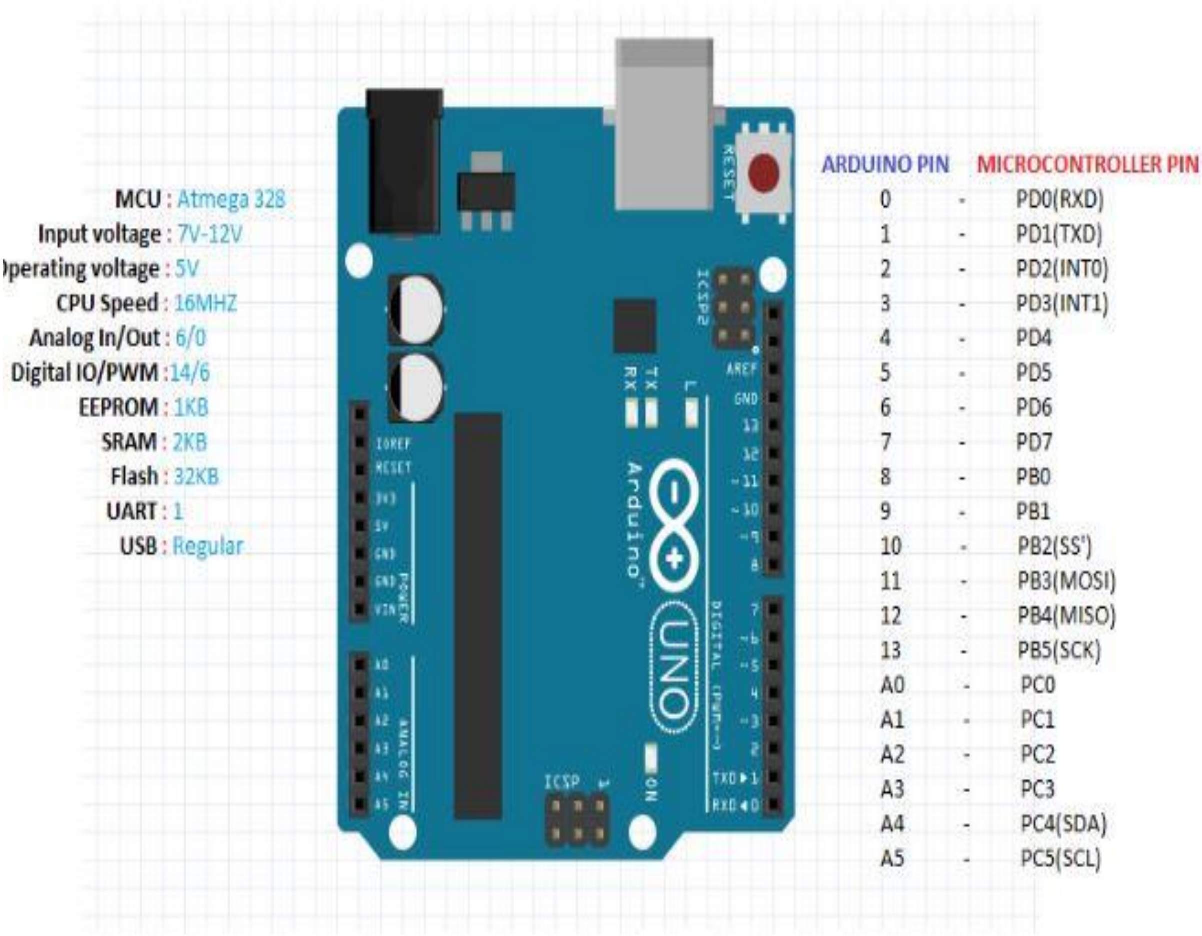
Table A.2: Raspberry Pi- Technical Specifications

Arduino Uno

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the Arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

Arduino Uno - Pinout diagram



Arduino Uno - Pin Description

Pin Category	**Pin Name**	**Details**
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Table A.3: Arduino Uno- Pin description

Arduino Uno - Technical Specifications

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Table A.4: Arduino Uno- Technical Specifications